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Improved Employment of S-5 Air-to-Surface Rockets in Land Warfare: A brief history and technical appraisal

Yuri Lyamin with N.R. Jenzen-Jones

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ABBREVIATIONS AND ACRONYMS

APC

Armoured personnel carrier

HE

High-explosive

HE-FRAG

High-explosive fragmentation

HEAT

High explosive anti-tank

HEAT/FRAG

High-explosive anti-tank and fragmentation

IFV

Infantry fighting vehicle

MBT

Main battle tank

MLRS

Multiple-launch rocket system

PD

Point detonating

PKT

Pulemet Kalashnikova tankovyy
(‘Kalashnikov tank machine gun’)

PDS

Point detonating, self-destroying

RDX

Research Department explosive

RHA

Rolle homogeneous armour

SNEB

Société Nouvelle des Établissements
Edgar Brandt

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INTRODUCTION

Air-to-surface rockets have fulfilled an important, yet improvised surface-to-surface role in numerous regional conflicts over the past thirty years.

Makeshift rocket launchers, whether converted from existing rocket pods or of an entirely improvised design, have featured in conflicts in Afghanistan, Iran, Iraq, the former Yugoslavia, Georgia, Libya and, most recently, the ongoing conflict in Syria. Most prominent amongst the rockets used in this manner are those of the Soviet (later Russian) S-5 series.¹ Over the past half a century, these rockets became one of the standard weapons for the majority of Soviet and later Russian combat aircraft and helicopters. Although Soviet forces began to supplement, and in some cases replace, S-5 rockets in many roles with the larger 80 mm S-8 series in the 1970s, the S-5 remains commonplace amongst the armed forces of many countries, particularly in the developing world.

S-5 rockets continue to be used in both the conventional manner and in improvised launchers. In many cases, improvised systems based around surface-to-air rockets are employed as makeshift multiple-launch rocket systems (MLRS), often in a standalone manner. Launchers in this configuration appear to be used predominantly for indirect fire support, and make use of improvised weapons mounts allowing high elevation. In other cases, such systems are employed in the direct fire support role. In these cases, the weapons may be used to supplement existing vehicle armaments, or in a standalone fashion. Launchers used like this are often pintle-mounted, or mounted in a fixed or coaxial position. In at least one documented example, an improvised S-5 system was claimed to be used in an anti-helicopter role. It is also important to note the existence of other systems, including both towed and immobile launchers, remotely-operated systems mounted on radio-controlled vehicles, and man-portable single-tube launchers, including shoulder-fired examples.

S-5 SERIES ROCKETS AND ROCKET PODS

S-5 rockets are unguided 57 mm air-to-surface rockets, the first versions of which were adopted by the Soviet Army in the 1950s.² They are fired from rocket pods, such as the ORO-57K (which may be loaded with up to 8 rockets), UB-16-57 (16 rockets), UB-32-57 (32 rockets), and their respective variants. Several S-5 variants³ have been produced by different manufacturing countries with various warhead and fuze combinations to fulfill different combat roles. The most common variants are outlined in Table 1.



Photo 1 A 57 mm S-5KO HEAT-FRAG unguided air-to-surface rocket in Libya.

Photo credit: Peter Bouckaert (Human Rights Watch)

TABLE 1: EXAMPLES OF NOTABLE S-5 ROCKET VARIANTS⁴

S-5M (and S-5M1)	HE-FRAG warhead ⁵ which produces 75 fragments weighing 0.5-1 g each
S-5MO	HE-FRAG warhead which produces 360 fragments weighing 2 g each
S-5K (and S-5K1)	HEAT warhead ⁶ which penetrates 130 mm RHA
S-5KO	HEAT-FRAG warhead ⁷ produces 220 fragments weighing 2 g each
S-5KP (and S-5KPB)	Sensitive piezoelectric fuze and HEAT-FRAG warhead
S-5S (and S-5SB)	Time fuze and warhead containing 1,000 - 1,100 flechettes
S-5O	Illuminating warhead.
S-5O1	Illuminating warhead with parachute
S-5P (and S-5P1)	Time fuze and chaff warhead

Several of these variants have been documented in improvised roles, including S-5M, S-5MO, S-5K, S-5KO, and S-5S rockets. On several occasions, the employing force's knowledge of the munitions has been limited. In some cases this has led to an incorrect type of S-5 fuze being selected for a particular rocket type—resulting in reduced combat effectiveness—whilst in other cases, fuzes for entirely different types of munitions have been employed. Documented examples have included artillery and other projectile fuzes. Whilst there are more details available on fuzes that have been documented in incorrect use with S-5 series rockets, some of which may result in limited effectiveness of the munitions or prove highly dangerous, this information is being withheld on security grounds.

TECHNICAL CHARACTERISTICS OF THE S-5M ROCKET⁸

Calibre	57 mm
Rocket length	882 mm
Fuse length	155 mm
Stabiliser fin span	232 mm
Rocket weight	3.86 kg
Warhead weight	815 g
Explosive composition	A-IX-2 (73% RDX, 23% aluminum powder, 4% wax)
Explosive weight	285 g
Fuze	Point detonating e.g. V-5M1

TECHNICAL CHARACTERISTICS OF THE V-5M1 FUZE⁹

Fuze type	Point detonating, self-destroying (PDSD)
Rockets intended for	S-5M, S-5M1, S-5MO, S-5KO, S-5O
Overall length	155.72 mm
Weight	265 g
Thread diameter	36 mm

TECHNICAL CHARACTERISTICS OF UB-16 AND UB-32 LAUNCHERS¹⁰

UB-16-57

Number of launch tubes	16
Calibre	57 mm
Length	1,678 mm
Overall diameter	321 mm

UB-32-57

Number of launch tubes	32
Calibre	57 mm
Length	2,080 mm
Overall diameter	464 mm



Photo 2 A UB-16-57 rocket pod capable of being loaded with up to 16 S-5 rockets of 57 mm, and its improvised firing system. Photos were taken after the discovery of a large consignment of weapons, allegedly smuggled out of Libya in 2012 aboard the ship Letfallah II. Photo credit: Syrian Free Press

A BRIEF HISTORY OF IMPROVISED S-5 SYSTEMS

Some of the first improvised rocket systems utilising S-5 rockets for land warfare were developed by Soviet forces themselves.

A limited contingent of the 40th Army of the Soviet Union stationed in Afghanistan in the 1980s developed what appears to be the first documented improvised system employing S-5 rockets in the surface-to-surface role. Although there was no shortage of artillery and close air support for Soviet troops, these capabilities were not always immediately available in the mountainous parts of the country (Włodawskie, 2012). As a result, some 40th Army units mounted additional light weapons, including rocket pods, on trucks, infantry fighting vehicles (IFVs), and tanks in order to strengthen their direct fire support capability. Rocket pods for S-5 rockets featured prominently in such conversions, with as many as three UB-32-57 launchers being mounted on a single T-62 main battle tank (MBT) in some instances (see Photo 3). This configuration would allow the tank to carry and employ 96 S-5 rockets, in addition to the standard 50 rounds of ammunition carried for its 115 mm U-5TS smoothbore main gun and its coaxial PKT machine gun. Photo 4, below, shows another example from the Soviet 40th Army in Afghanistan, a Ural 4320N truck modified with part of the hull and turret from a damaged BRDM-2 IFV and a UB-32-57 rocket pod recovered from a downed helicopter.



Photo 3 Soviet T-62 MBT in Afghanistan in the 1980s, with three UB-32-57 launchers mounted on an improvised platform above the turret.

Photo credit: Herald of Mordovia, 2013



Photo 4 Soviet Ural 4320N truck in Afghanistan in the 1980s, with a UB-32-57 rocket pod mounted atop an improvised conversion of a BRDM-2 turret.

Photo credit: Włodawskie, 2012



Photo 5 Soviet BTR-70 IFV in Afghanistan in the 1980s, with a UB-16-57 rocket pod in an improvised mount about the turret. From photo archive of Aksenenko Sergei, commander of the 3rd Battalion, 122nd Regiment of the 201st Motorized Rifle Division, Soviet 40th Army in Afghanistan from 1982-84.

Photo credit: Memorial Museum of 'Shuravi' Soldier-Internationalists

The practice of mounting S-5 rocket pods to armoured vehicles has also been documented in another major conflict of the 1980s. A captured Iraqi MT-LB multipurpose armoured vehicle was photographed on display at an exhibition devoted to the Iran-Iraq war, in the Iranian city of Semnan (see Photo 6). The vehicle has been fitted with four UB-32-57 launchers, enabling it to be loaded with up to 128 S-5 type rockets. It is not clear whether the vehicle was captured from Iraqi forces as pictured, or whether it was retrofitted by Iranian troops at a later date.



Photo 6 A captured Iraqi MT-LB retrofitted with four UB-32-57 rocket pods on display in Iran.

Photo credit: Islamic Republic News Agency

However, despite these and other cases, the use of unguided air-to-surface rockets in land warfare does not appear to have been widespread in the 1980s. The 57 mm S-5 and other similar rockets are less effective than many larger alternatives, and their already low accuracy is further diminished when firing from an improvised platform in an unintended role. Therefore, such systems proved little more than curiosities in regular armies, developed as field expedient solutions to fulfill specific operational needs. Whilst rebel groups were more likely to continue employing such systems, most did not have access to sufficient numbers of air-launched rockets to keep them operationally viable.

The situation changed dramatically in the early 1990s, following the disintegration of the Soviet Union and Yugoslavia. More than two dozen new states were formed on the former Soviet and Yugoslav territories, and bloody ethnic conflicts erupted. Some of these fledgling countries had insufficient combat aircraft, pilots, or logistical support networks to effectively field a close air support capability, but had access to large stores of aircraft munitions, which in many cases had been left behind during the Soviet withdrawal. As a result, during the conflicts waged in ex-Soviet and ex-Yugoslavian republics in the 1990s, numerous fighting forces fielded improvised MLRS and direct fire support vehicles based around unguided air-to-surface rockets. Chief amongst these were systems firing the 57 mm S-5 and 80 mm S-8 rockets.

Improvised systems firing the S-5 were mounted on MBTs, IFVs, and other armoured vehicles, as well as both military and civilian trucks. Conflicts in the former Yugoslavia also brought to light one of the earliest documented examples of man-portable S-5 rocket launchers, with single tube craft-produced, improvised models being employed. The following examples of improvised systems used in the Eastern European regional conflicts of the 1990s show some of the many configurations developed (Photos 7 through 13).



Photo 7 A modified Yugoslavian produced M-60P armoured personnel carrier (APC) with a UB-32-57 rocket pod. This vehicle was pictured at Kozare Museum (Muzej Kozara) in Banja Luka, Bosnia and Herzegovina.

Photo credit: Edi Jankovic



Photos 8 and 9 A TAM-110 truck operated by Republika Srpska forces in Bosnia and Herzegovina in the mid-1990s, fitted with two UB-16-57 rocket pods.
Photo credit: UK Ministry of Defence





Photo 10 Portable single-tube launcher for 57 mm rockets from an unknown party to the conflicts in the former Yugoslavia in the 1990s. This launcher appears to be based around a single launch tube removed from a standard rocket pod.

Photo credit: Srpski Oklop!



Photo 11 A TAM-110 truck with a UB-32-57 launcher operated by the Republic of Serbian Krajina militia during the conflict in Croatia in the early 1990s.

Photo credit: Srpski Oklop!



Photo 12 A Georgian Army BMP-1 AFV with a stripped-down UB-16 type rocket launcher. This particular improvised system was described as being employed in an anti-helicopter role.

Photo credit: Flickr user 'Cold War Warrior'



Photo 13 MT-LB multipurpose armoured vehicle with UB-16-57 rocket pod. Photo taken in Kutaisi, Georgia in 1998.

Photo credit: Flickr user 'Cold War Warrior'

Another conflict where such improvised weapons became widespread was the Afghan civil war in the late 1990s and early 2000s. After the loss of Soviet military aid, the overthrow of the Najibullah government and the subsequent struggle for power between different factions saw the Afghan National Air Force fall into almost total decay (Haulman, 2012). Vast stocks of aircraft armaments, including S-5 rockets and their associated launchers, were repurposed for land warfare. Mostly mounted on light vehicles in the 'technical' configuration, UB-16-57 (see photos 14 and 15) and UB-32-57 rocket pods were employed in both indirect and direct fire support roles.



Photo 14 and 15 Improvised rocket systems based on UB-16-57 launchers in Afghanistan in the late 1990s or early 2000s.

Photo credit: armourbook.com user 'Katran33'

Although improvised systems firing air-to-surface rockets had become commonplace in some armed conflicts of the 1990s and early 2000s, it was only during the Libyan civil war in 2011 that these weapons became one of the primary systems used in many of a conflict's land battles. S-5 rockets, amongst others¹¹, were used with a variety of improvised systems, ranging from single-barrel man-portable rocket launchers to UB-32-57 rocket pods mounted on pickup trucks.

Rebel forces in Eastern Libya were able to rapidly capture the government's airbases and large weapons depots (Knights, 2011), but lacked combat aircraft and trained fighter pilots. Large stockpiles of S-5 rockets were captured early in the revolution, and rebel forces without conventional combat vehicles sought to capitalise on them immediately. Libyan Army forces that opposed the rebels were restricted in their use of armoured vehicles after the start of air strikes executed by the NATO-led multi-state coalition. As a consequence, anti-government forces were able to field large numbers of light improvised fighting vehicles ('technicals'), and equipped significant numbers of these with S-5 rocket pods (Jenzen-Jones, 2012). The following photos (Photos 16 through 21) show several different configurations of S-5 rocket launchers employed during the Libyan civil war.



Photo 16 and 17 Improvised man-portable, shoulder-fired single-tube rocket launcher for 57 mm S-5 rockets. Photos were taken after the discovery of a large consignment of weapons, allegedly smuggled out of Libya in 2012 aboard the ship Letfallah II.

Photo credit: Syrian Free Press



Photo 18 UB-16-57 launcher mounted on a pickup truck in Libya, in 2011.

Photo credit: Aris Roussinos



Photo 19 Rebel combatants load a UB-32-57 rocket pod mounted on a pickup truck at the front line along the western side of Ajdabiyah on 19 April 2011.

Photo credit: Reuters/Amr Abdallah Dalsh



Photo 20 Radio-controlled vehicle with improvised four-tube rocket launcher for 57 mm S-5 rockets in Libya.
Photo credit: 17-feb.com



Photo 21 Improvised sixteen-tube rocket launcher for 57 mm S-5 rockets in Libya.
Photo credit: Vadim Naninets

Given the prevalence of improvised S-5 systems in the Libyan civil war, it is perhaps somewhat surprising that similar weapons have not taken centre stage in the ongoing conflict in Syria. Improvised rocket launchers firing air-to-surface rockets are comparatively rare in what can be observed in Syria, and appear to be only used in the form of vehicle-mounted improvised MLRS, rather than man-portable or other systems. Images and video from Syria show that both pro-government forces and the armed opposition are making use of improvised MLRS using S-5 rockets (Jenzen-Jones, 2013).

Surface-to-surface rocket systems appear to be prevalent in greater numbers in Syria than in the Libyan conflict, including 107 mm (largely type 63), 122 mm BM-21, as well as 240 mm and 333 mm Falaq-1 and Falaq-2 rocket launchers (Jenzen-Jones et al., 2014), which may partially explain the absence of air-to-surface rockets in improvised use. Additionally, Muammar Gaddafi, then President of Libya, was well known for the massive variety and quantities of arms imported into Libya, with many analysts assessing that the quantities of arms and munitions purchased far exceeded any realistic expectations of use (Feinstein, 2011). Finally, Gaddafi's air power was severely curtailed by the coalition intervention, whereas President Assad's forces in Syria have continued to operate both rotary and fixed-wing aircraft, and have made ongoing use of S-5 rockets in combat operations. It is likely there were significantly greater stockpiles of both S-5 rockets and their associated launchers available to rebel forces in Libya than those in Syria. In at least one documented case, improvised rockets have been seen in use with launchers configured for the S-5.

It is also worth noting that the Syrian conflict has seen more prolonged fighting in dense urban areas, where the comparatively weak warheads of S-5 type rockets are less effective than larger rocket systems. Even the Syrian Air Force appears to have supplemented its use of S-5 type rockets where possible, shifting towards 80 mm S-8 and 240 mm S-24 rockets¹².



Photo 22 UB-32-57 launcher mounted on a pickup truck of one of the Syrian armed opposition groups.

Photo credit: Laith al-Sham



Seen on MilInME.wordpress.com

جزء من الرتل العسكري الذي توجه إلى ريف حماه

Photo 23 Syrian Arab Army or pro-government militia Hyundai Mighty light truck with UB-32-57 launcher.
Photo credit: SyriaTube



Photo 24 Anti-government fighters load an improvised S-5 type rocket into a UB-32-57 rocket pod in Syria.
Photo credit: Al Jazeera

PURPOSE-BUILT SYSTEMS

There have been limited examples of countries developing purpose-built systems designed to employ S-5 rockets in the surface-to-surface role.

In the 1990s, Ukraine developed a prototype based on the LuAZ-969M light vehicle with a mounted UB-32-57 rocket pod (see photo 25). In 2012, Azerbaijan demonstrated a prototype turret designed to be mounted onto BRDM-2 IFVs, featuring a new design of S-5 rocket pod (see photo 26). Both of these examples are believed to have progressed no further than the prototype stage. It is likely that the inherent inaccuracy of such systems, as well as the relatively weak warheads of the S-5 series, made such systems of limited value to a conventional military.



Photo 25 Ukrainian prototype MLRS vehicle based on a LuAZ-969M truck with UB-32-57 rocket pod. Pictured in 1998.
Photo credit: Monetchikov, 1998



Photo 26 President Ilham Aliyev of Azerbaijan is shown a prototype turret with S-5 rocket pod, designed to be mounted to BRDM-2 IFVs, in 2012.
Photo credit: Trend News Agency

CONCLUSION

S-5 air-to-surface rockets have been used in improvised surface-to-surface roles in at least six major conflicts, from the 1980s to present day. While S-5 rockets have been used increasingly in land warfare during recent conflicts, it is clear that they are predominantly employed when more suitable munitions are not available. The effectiveness of improvised S-5 based systems is typically low, due to the inherently weak payload of S-5 series rockets and the low accuracy of improvised systems. The accuracy of these weapons is further reduced when they are employed in the indirect fire support role, as seen with many of the improvised MLRS systems documented. In some cases, incorrect selection and employment of fuzes also appears to result in lowered effectiveness.

Improvised systems built around the S-5 series rockets are most effective when used as a means of direct fire support against infantry and light vehicles in open terrain. With HEAT rockets, such as the S-5K, S-5K1, or S-5KO, such systems may be capable of engaging light APCs and IFVs. Against heavier armoured fighting vehicles and in urban areas, the effectiveness of such systems is dramatically reduced. Nonetheless, large stockpiles of S-5 series munitions in developing countries make it likely that improvised systems based around these rockets will continue to play a part in future conflicts.

NOTES

- 1 Other air-to-surface rockets have been documented in use with improvised systems, including the 80 mm Soviet-designed S-8 series, and the French 68 mm *Société Nouvelle des Établissements Edgar Brandt* (SNEB) series.
- 2 The S-5 was inspired by the German R4M (*Rakete, 4 kilogramm, Minenkopf*) Orkan series of unguided 55 mm air-to-surface and air-to-air rockets.
- 3 There are thought to be as many as 24 variants.
- 4 Source: *Wings of the Motherland*, 1994, pp 21-23.
- 5 High-explosive fragmentation warhead
- 6 High-explosive anti-tank warhead
- 7 High-explosive anti-tank and fragmentation warhead
- 8 Source: Ministry of Defence of the USSR. 1961. Aircraft Missile S-5M and Mechanical Impact Fuze V-5M1.
- 9 Source: Ministry of Defence of the USSR. 1961. Aircraft Missile S-5M and Mechanical Impact Fuze V-5M1.
- 10 Source: Shirokorad, A.B. 1999.
- 11 68 mm SNEB rockets, and associated Matra F1 rocket pods, were a notable part of the Libyan Air Force inventory and were seen in improvised service during the conflict.
- 12 Observation made from the authors' viewing of hundreds of videos from the ongoing Syrian conflict.

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